TMDL Development

- **Model Development ☸**
- **Problem Assessment ☸**
- **TMDL 🗁**

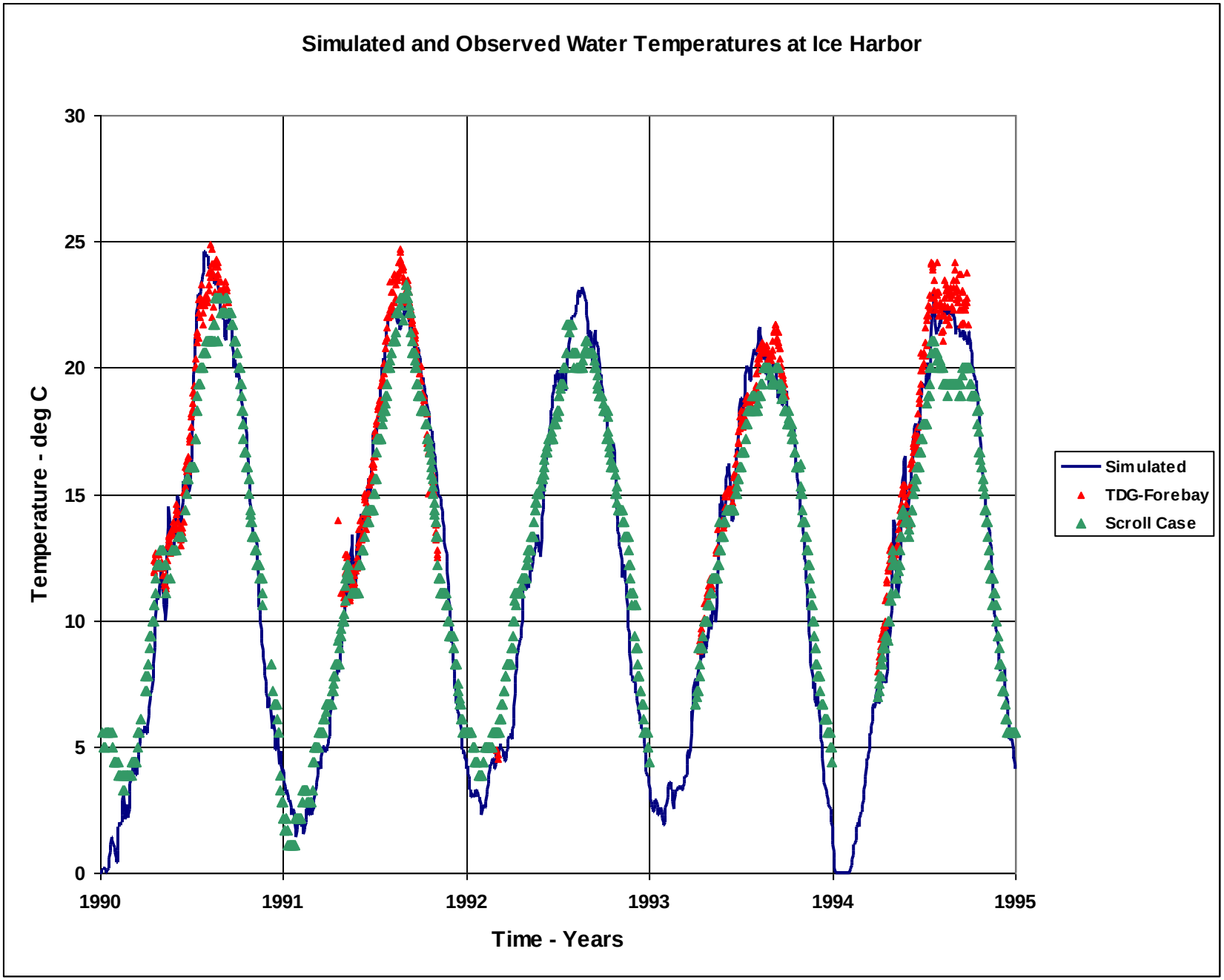
Model Name

- **River**
- **Basin**
- **Model developed in EPA Region**
- **10**

- **RBM10 is written in Fortran code and can be adapted to simulate any large scale river**

Why Do We Need Process Model?

- We need to estimate temperatures under un-impounded conditions for which measurement data is scarce
- We have conflicting measurements
- We do not have measurements at all river locations of interest
- We need to estimate influence of different sources


Simulated and Observed Water Temperatures at Ice Harbor
Temperature - deg C
0
5
10
15
20
25
30
1990
1991
1992
1993
1994
1995
Time - Years
Simulated
TDG-Forebay
Scroll Case

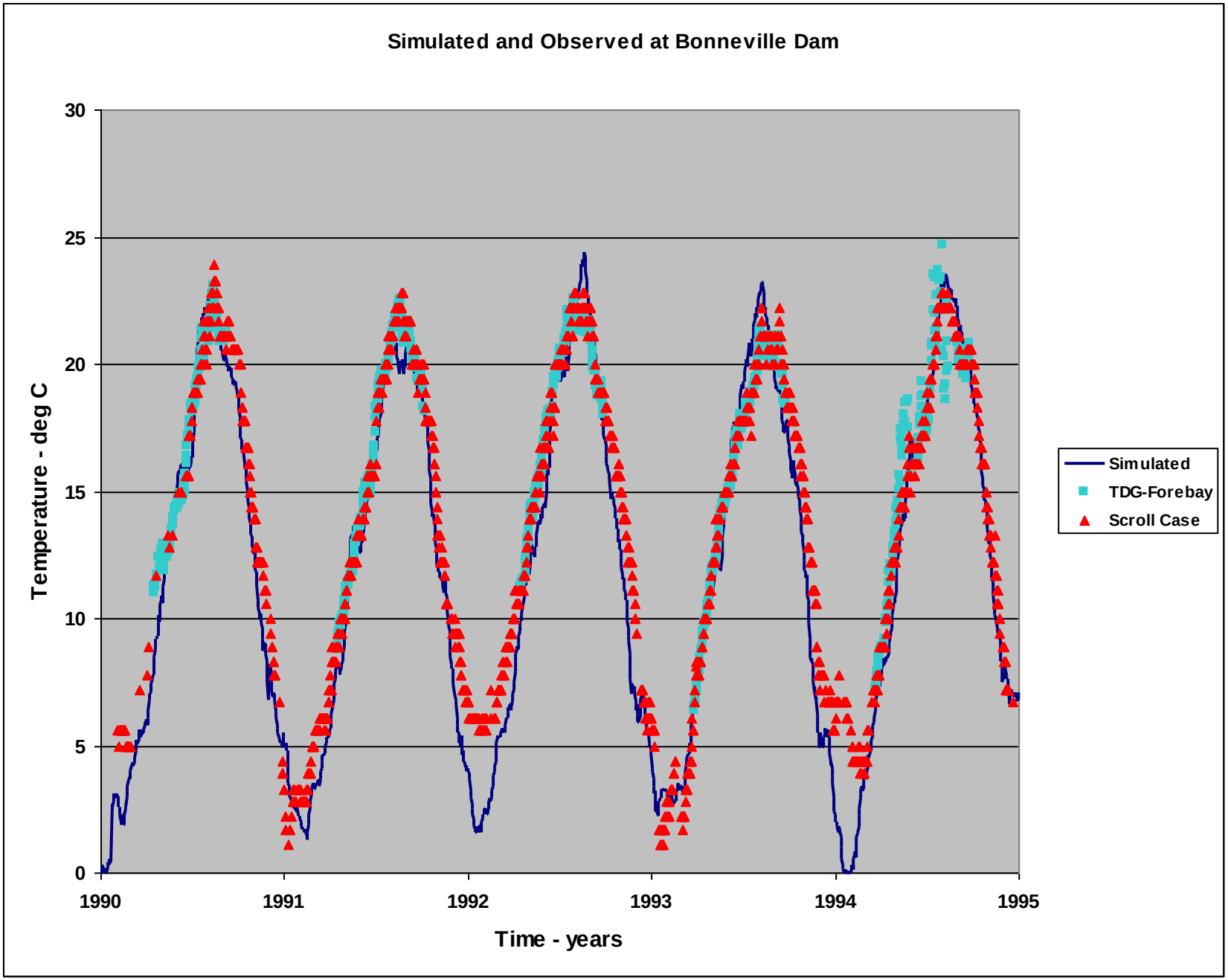

Simulated and Observed at Bonneville Dam
Temperature - deg C
30
25
20
15
10
5
0
1990
1991
1992
1993
1994
1995
Time - years
Simulated
TDG-Forebay
Scroll Case

Figure D-6. Regression of observed on simulated at Ice Harbor Dam 1990-1995

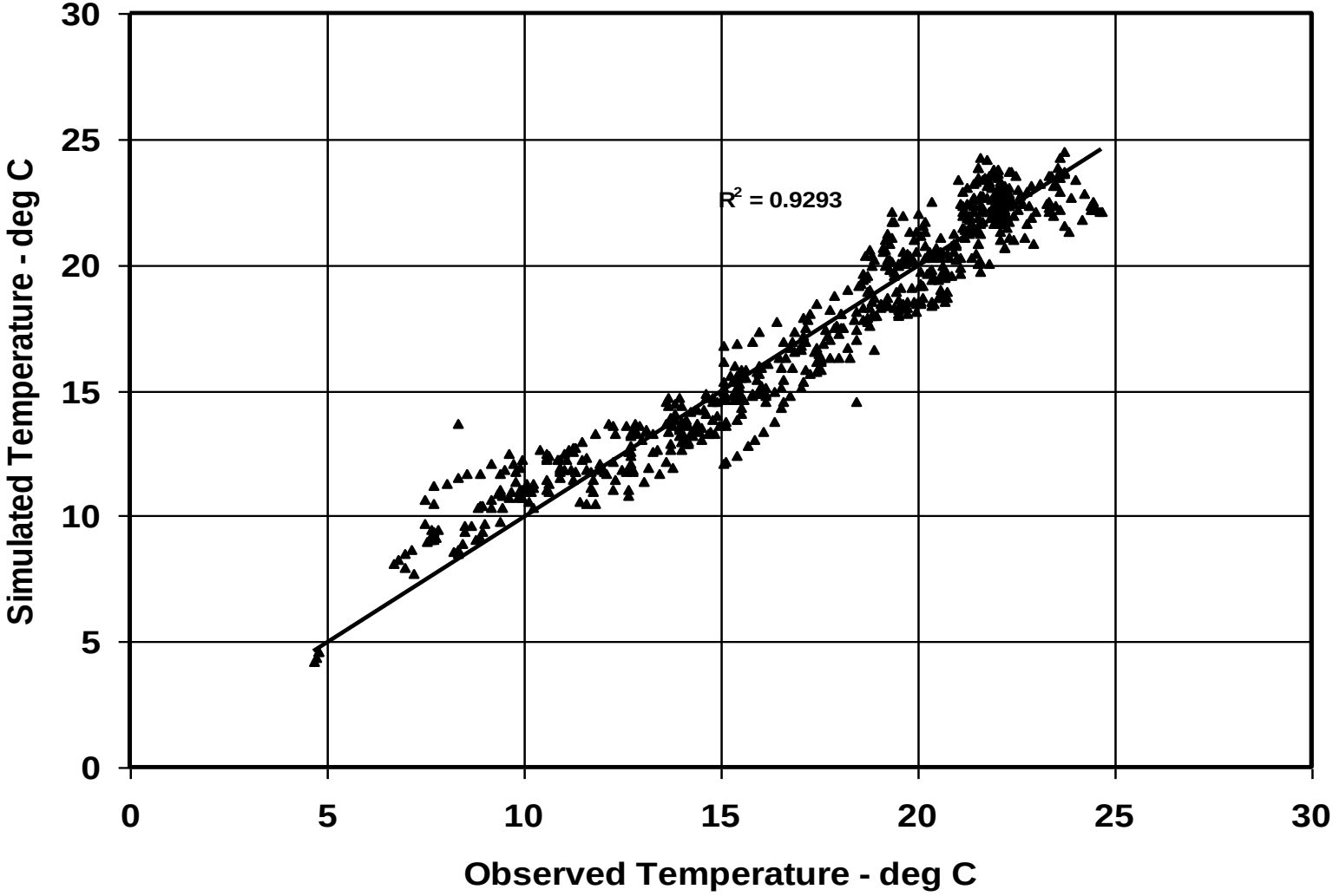
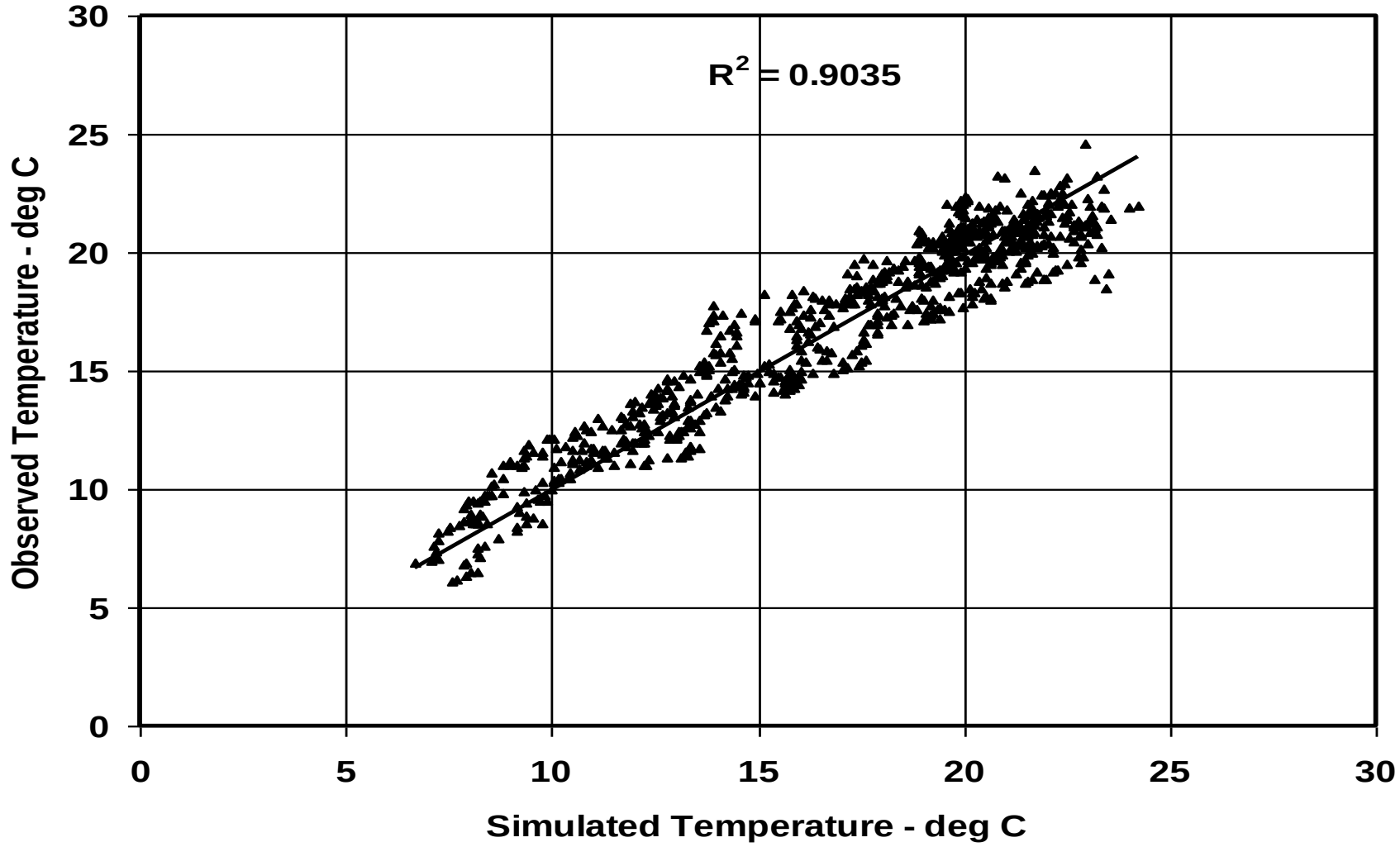


Figure D-5. Regression of observed on simulated at Bonneville Dam 1990-1995.



RBM10 Results for 1990-1994

Location	*Mean Difference (Obs-Sim)*	*Standard Deviation*
Snake River @Ice Harbor	0.05 deg C	1.2
Columbia River @Bonneville	0.04 deg C	1.3

Error Estimates from Other Studies

- **RISLEY (1997) - Tualatin River**
  Max Mean Difference = 3 Deg C
  Mostly < 1 Deg C

- **BATTELLE-MASS1 (2001) - Columbia River**
  RMS Error = 0.59 - 1.52 Deg C

- **HDR/PORTLAND STATE/IPC (1999) - Snake River**
  AME = 0.6-2.3 Deg C (1992 data)
  AME = 0.5-2.0 Deg C (1995 data)

- **CHEN (1996) - Grande Ronde River**
  Error = -2.20 - 8.28 Deg C (Summer Max)
  Error = -1.21 - 7.69 Deg C (Avg 7-day Max)

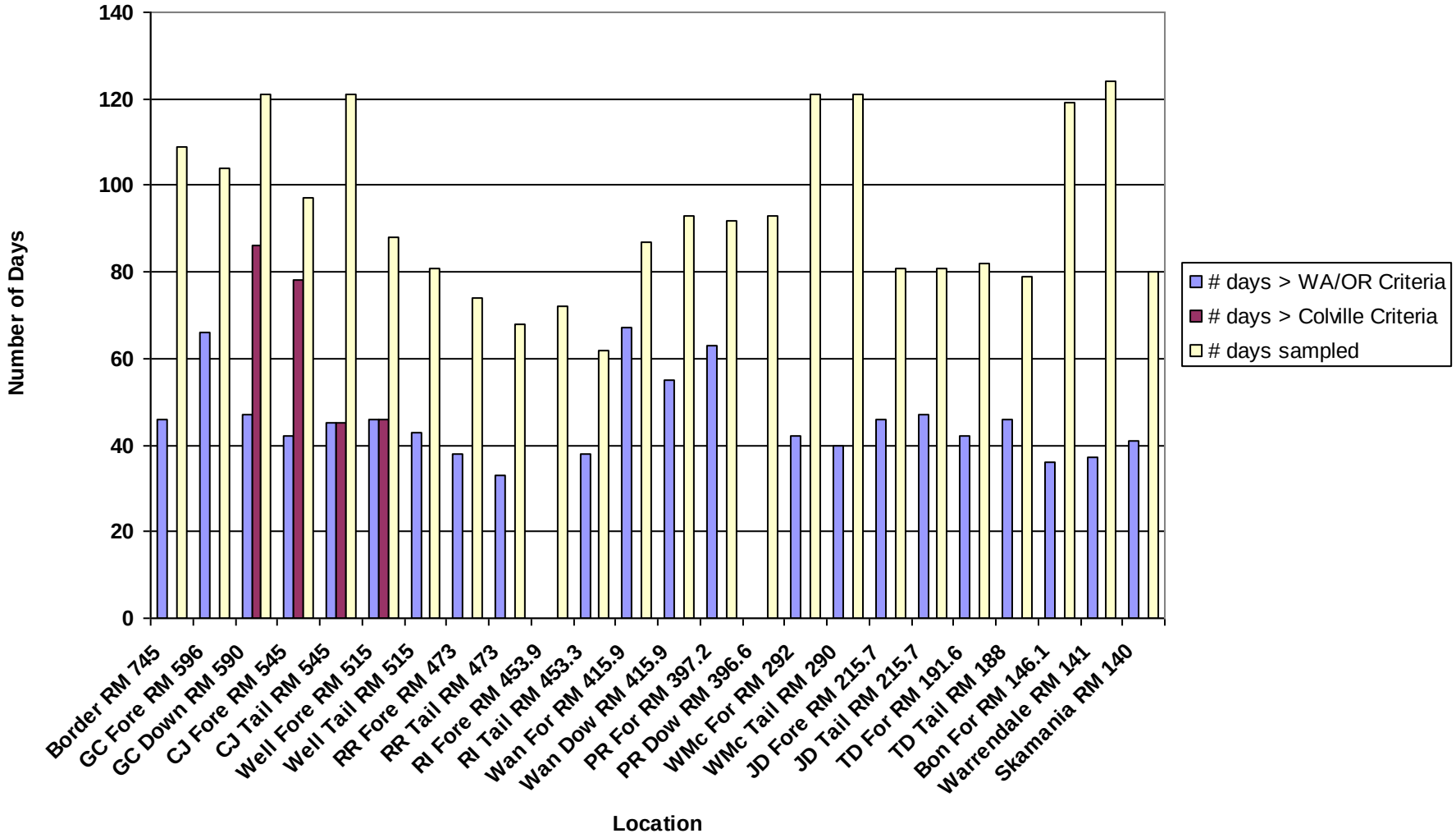
Problem Assessment

- Does water temperature in the Columbia and Snake Rivers exceed Water Quality Standards?

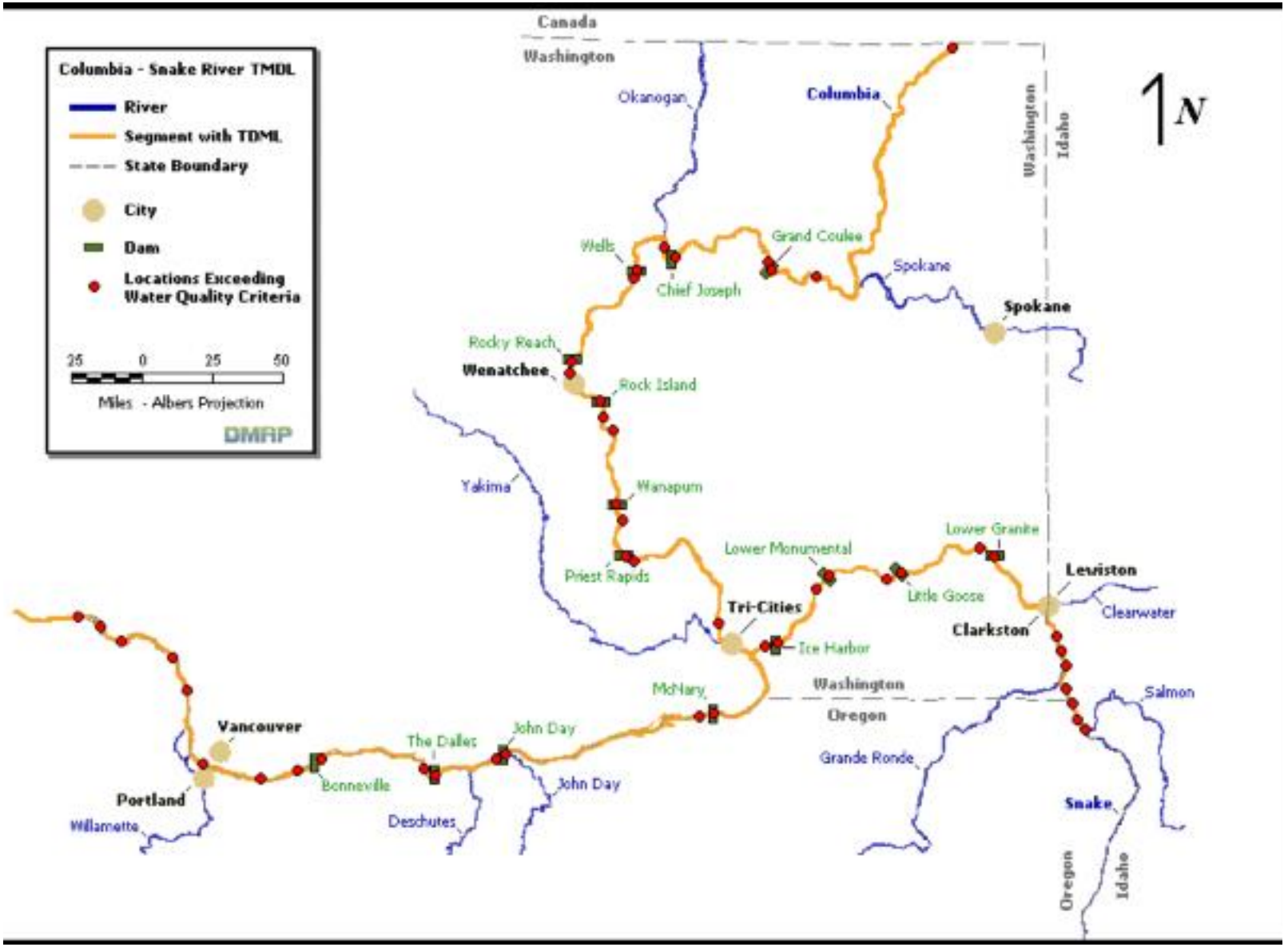
Problem Assessment

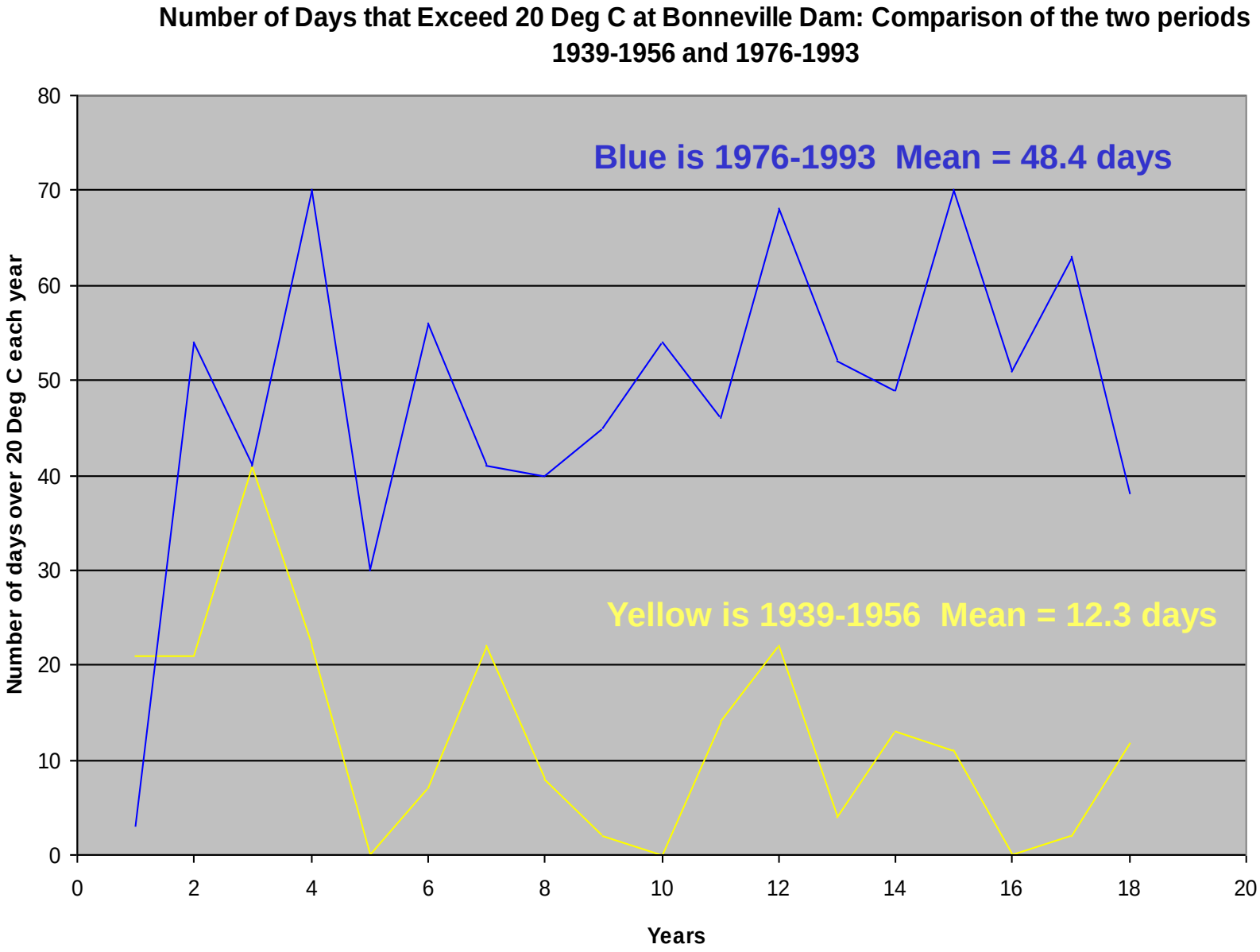
- 1) Does temperature exceed the Water Quality Criteria?
- 2) Does temperature exceed the Water Quality Criteria due to human activities?

July Through October, 2000 - Number of Days during which Water Temperature along the Columbia River Exceeded Water Quality Criteria



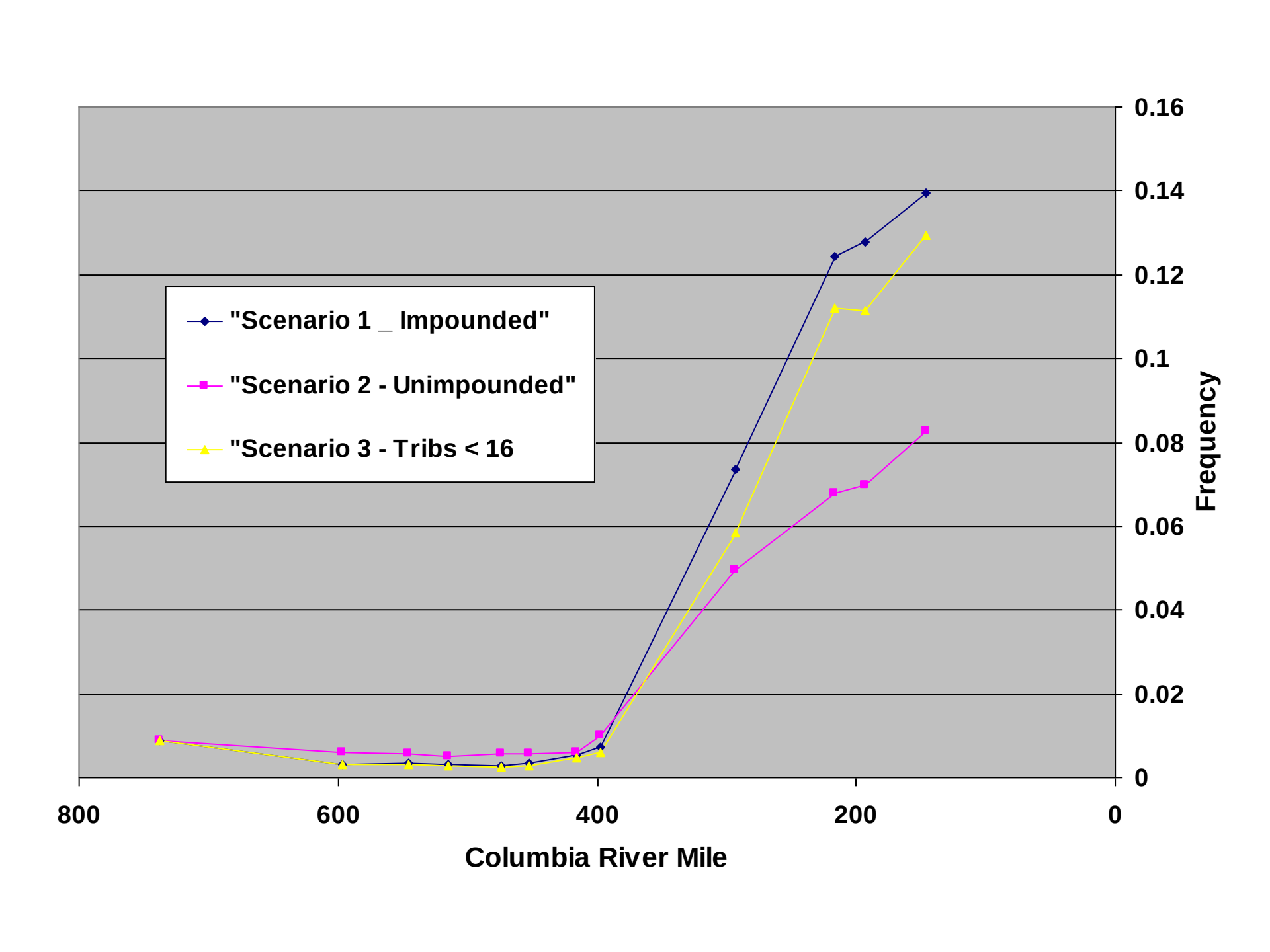
Geographic Scope



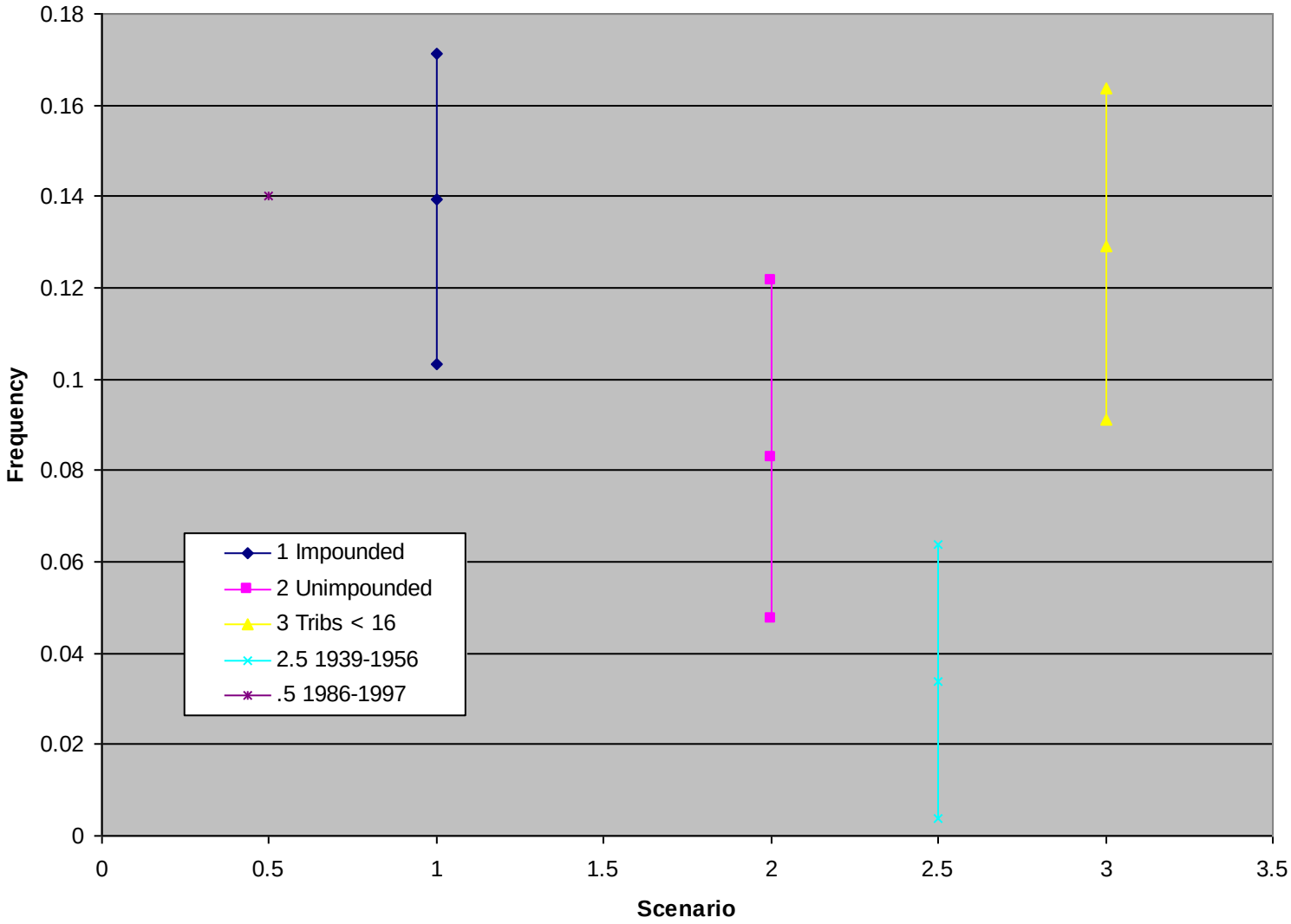

Number of Days that Exceed 20 Deg C at Bonneville Dam: Comparison of the two periods 1939-1956 and 1976-1993
Blue is 1976-1993 Mean = 48.4 days
Yellow is 1939-1956 Mean = 12.3 days
Number of days over 20 Deg C each year
Years
0
10
20
30
40
50
60
70
80
0
2
4
6
8
10
12
14
16
18
20

Problem Assessment

- Principle cause for the warming trend in the rivers is the presence of the dams.
- Climate change likely contributes to the trend to a lesser extent.
- Non-point and point sources contribute to a small extent.

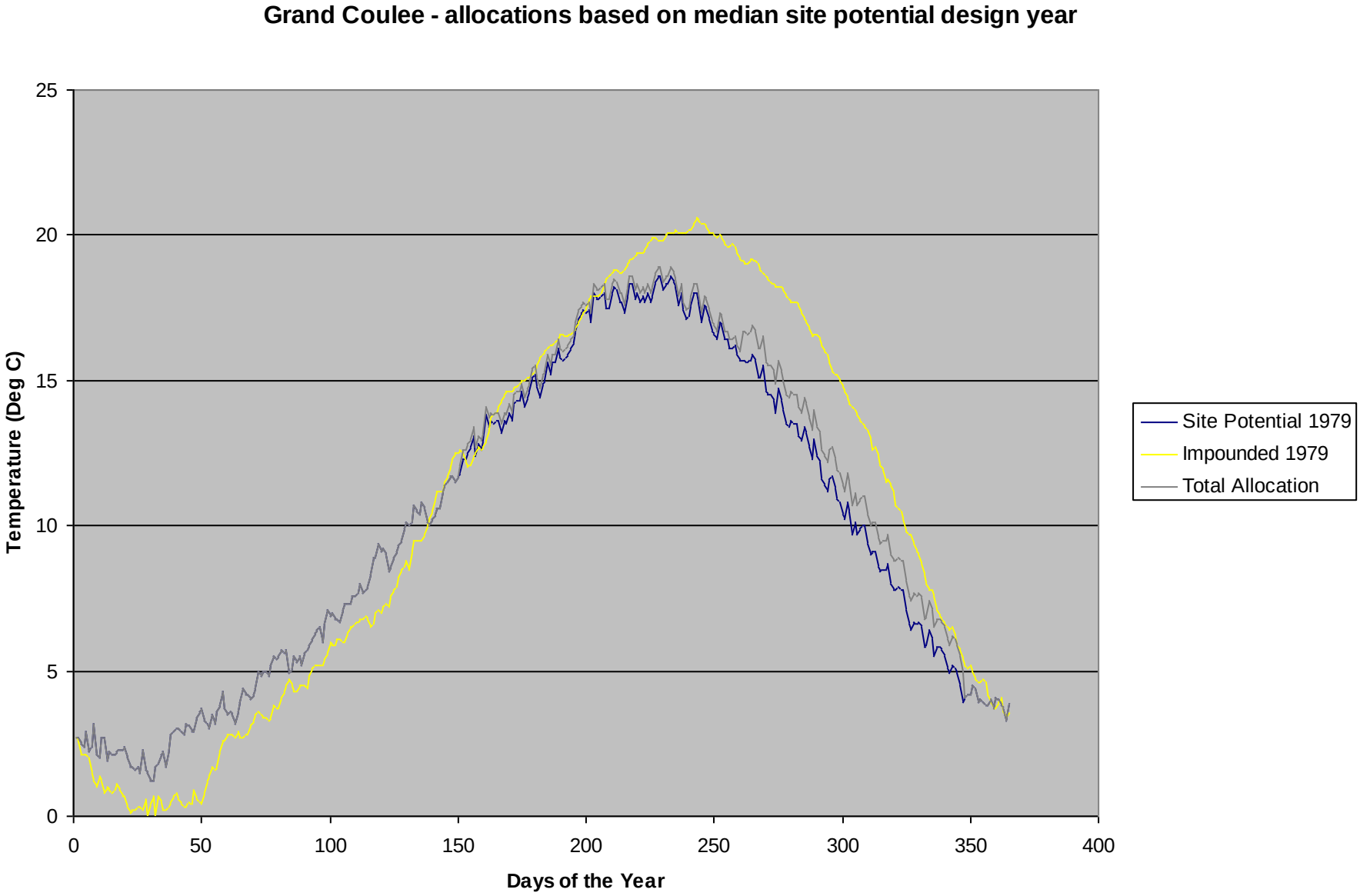

"Scenario 1 _ Impounded"
"Scenario 2 - Unimpounded"
"Scenario 3 - Tribs < 16
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Frequency
800
600
400
200
0
Columbia River Mile

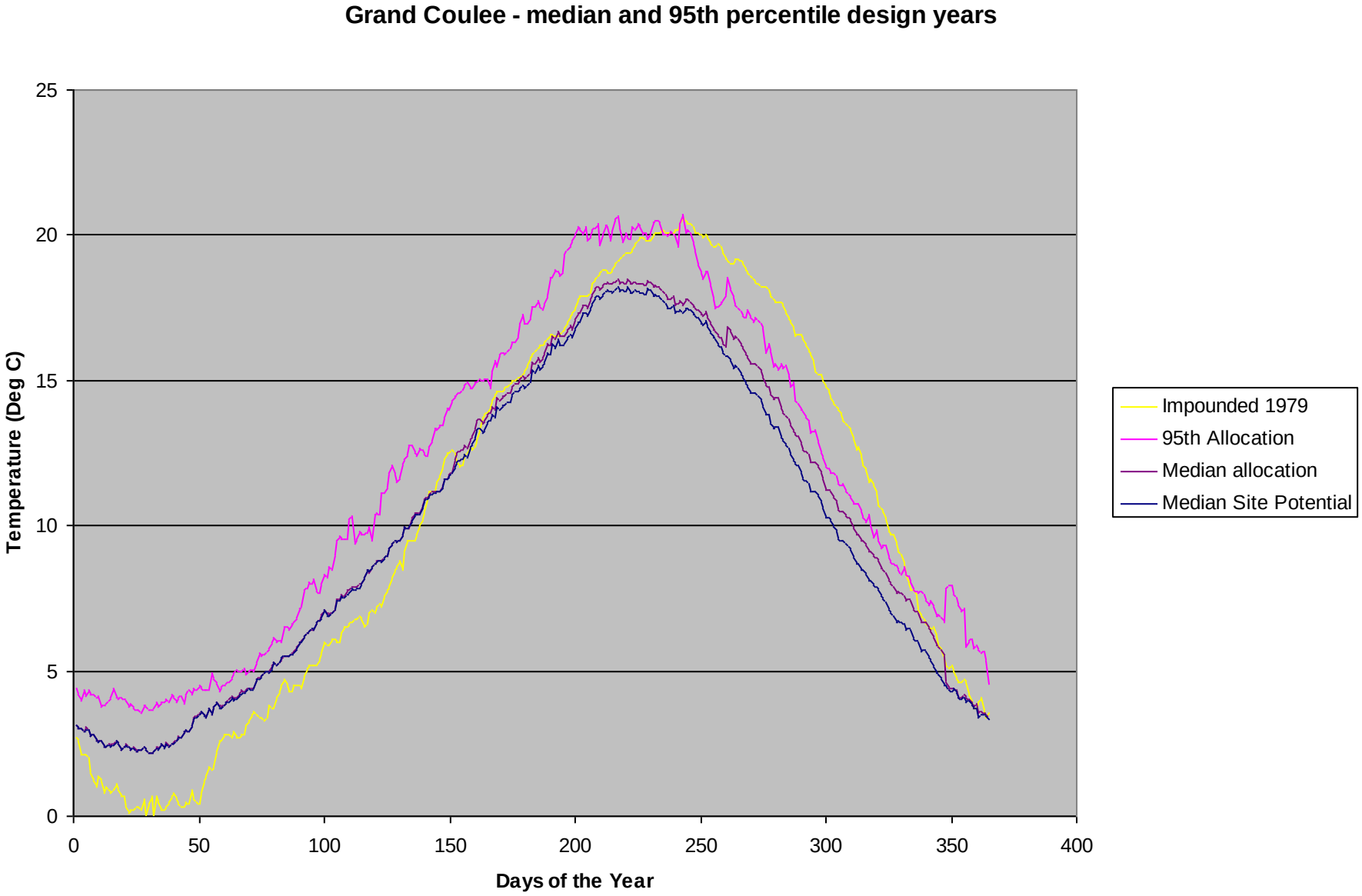
Frequency of Exceedance of 20 deg C at Bonneville Dam: Simulations and Observations



TMDL

- The target temperature for the TMDL is site potential (SP) temperature + small increment allowed by the WQS.
- (eg SP + 0.14 ºC when SP>20 ºC and SP + 1.1 when SP<20 ºC in the lower Columbia.)


Grand Coulee - allocations based on median site potential design year
Temperature (Deg C)
0
5
10
15
20
25
0
50
100
150
200
250
300
350
400
Days of the Year
Site Potential 1979
Impounded 1979
Total Allocation


Grand Coulee - median and 95th percentile design years
Temperature (Deg C)
25
20
15
10
5
0
0
50
100
150
200
250
300
350
400
Days of the Year
Impounded 1979
95th Allocation
Median allocation
Median Site Potential